Water-Borne Diseases, Cost of Illness and Willingness to Pay for Diseases Interventions in Rural Communities of Developing Countries

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Abstract

Background: Almost one third of the global population is living in developing South Asia where disease occurrence is high especially in rural areas and people are unaware of water-borne diseases and cost of illness.

Methods: The quantitative approach involved questionnaire based study (n=50 households). The community awareness, the occurrence of water-borne diseases with related cost of illness and community participation for the introduction of health interventions for water-borne diseases were evaluated through cross-tabulations, correlations, and ANOVA.

Results: Majority (40%) of the community had no knowledge of water-borne diseases except some had little knowledge of diarrhea and typhoid. Diarrhea followed by stomach diseases was widespread in the community. Population below poverty level was bearing the cost of illness around US$ 0.6—1.2 (Rs 50—100) per day followed by low and average income level with direct cost of US$ 2.3 (Rs 200) per day. The indirect cost of illness had showed increasing trend between US$ 2.3—4.7 (Rs 200-400) per day with increase in income levels. Maximum willingness to pay (WTP) for water supply and sewerage system was US$ 3.6 (Rs 300) and US$ 1.2 (Rs 100) per month respectively. Income and water supply demand was strongly correlated with acceptability to pay for the facilities ($r = 0.319, 0.307; P < 0.05$). Income had a strong influence on WTP for water and sewerage system ($r = 0.805, 0.797; P < 0.05$).

Conclusion: To maintain rural health, water-borne diseases can be reduced by introducing health interventions like proper water and sanitation facilities.

Keywords: Water-borne diseases, Community awareness, Cost of illness, Diseases interventions, Willingness to pay

Introduction

Provision to safe drinking water is of great concern in most of developing countries (1). Access to basic facilities like clean water supply and better sanitation is the need of the hour. In Asia and Pacific region, about to 7000 million people are living without proper water supply system especially in rural areas. About to 70 % of the population in Pakistan rely on ground water and high rate abstraction is causing decline in water table (2). Water contamination is caused by sewerage and industrial effluents, surface run-off and many anthropogenic activities that alter the physical (co-lour, taste, and smell) and chemical characteristics of water. Polluted and contaminated water can cause waterborne diseases like cholera, typhoid fever, malaria, amoebiasis, and dysentery (3—5). Globally water related diseases are responsible for the death of more than 5 million people annually. Absence of adequate and safe water supply and sanitation systems is responsible for sickness and death in developing countries (6). Water-borne pathogens are infecting 250 million people per year resulting in 10-20 million deaths (7). It is reported that in developing countries, water and

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sanitation are responsible for high illnesses (8) and diarrhea is responsible for about 4 billion deaths in children under five year of age (9). In Pakistan around 250,000 children under five year of age die each year by diarrhea. Frequent waterborne diseases and illness has increased the cost of medicinal facilities and poverty among rural communities (2).

In rural areas, there are no proper water supply and sewerage systems so water contamination can be attributed to infiltration, leaching, and surface run-off through pastures, lacking and leakage of sewerage disposal systems in villages (10). Poor water quality is responsible for disease outbreaks in many parts of the developing world. In order to reduce diseases outbreaks, there must be some interventions (11). There is need to provide drinking water systems according to water quality standards which will reduce diseases (12). Water and sanitation management practices can decrease diarrhea incidences by one-third to one-fourth (9). To avail the facilities, community participation and adoption policy is also needed (13). People's willingness to pay will show that how much they value such resources. There are usually two basic strategies to set domestic price levels like supply and demand-side based strategies. Demand side based strategies consider affordability for users and social equity for the resource (14). Willingness to pay is considered as a positive attitude of the community to pay bills. The knowledge about the linkages between willingness to pay and water quality, will assist suppliers in anticipating problems that require immediate, medium-term, or long-term attention (15).

The aim of the study was to examine the health status, occurrence of water-borne diseases with cost of illness, to explore problems related to water, and sanitation systems in that vicinity along with people's willingness to pay for proposed water and sanitation facilities for introduction of diseases interventions.

Materials and Methods

Site Characteristics
The area selected for the study purpose was a rural community (Saggian Khudayar; 31°34'12"N

and 74°11'33"E) of Lahore, Pakistan situated across the River Ravi and adjacent to the area Nainsukh. There is not any public water supply system in the community. Extraction of ground water is being done through motor pumps at each access. Poor sanitation and sewerage system is also creating chaos.

Research Design
In order to achieve the desired objectives, two basic data collection techniques were used as shown in the Fig. 1. For the collection of primary data, quantitative approach was used that incorporated questionnaire based study where as secondary data related with water-borne diseases was collected from basic health unit and nearest hospital of the area.
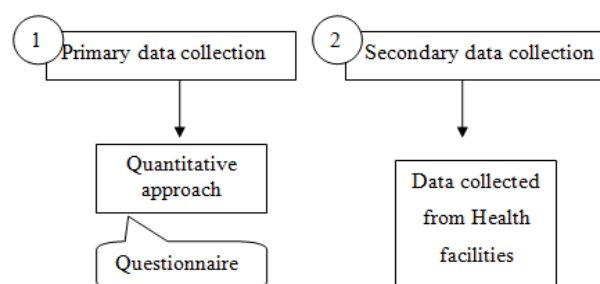

Fig.1: Research Design

Questionnaire Layout
The questionnaire was designed up to 66 items comprised of various sections which included personal profile of respondents such as age, occupation and level of education, housing conditions, water and diseases perception and awareness, occurrence of water-related diseases, cost of illness and people acceptability and willingness to pay for water and sanitation services (4, 16).

Cost of illness
Cost of illness was investigated through the questionnaire as direct and indirect cost of illness per day. Response rate was collected for the direct cost of illness (that respondents had to bear for medication per day with respect to diseases exposure as once in a month, two and six months) and indirect cost of illness (that the respondents had

to forgo their income in the time of diseases prevalence in case of loss of working days). Here, direct cost of illness was calculated by cross tabulating "exposure to disease" with cost of medication per day.

Willingness to Pay

This section included the questions about how the respondents value water, people acceptability to pay and how much they are willing to pay for water and sanitation related services (17). In order to assess people's willingness to pay (WTP) for piped water, the Contingent Valuation method (CVM) was applied. A closed-ended question format was adopted. On scale, minimum price for water supply was zero and maximum up to US$ 4.7 (Rs 400) per month.

Subject Matter

The unit of inquiry was a household person. For each household, the questionnaire was administered with the head of the household. A representative sample size of 50 households was selected at random out of 500 households. In order to ensure validity of questionnaire, pilot survey was conducted from 15 households.

Data investigation

All the data obtained through questionnaire was analyzed through Ms. Excel and Statistical Package for Social Sciences (SPSS) to demonstrate graphical representation of various data characteristics, descriptive analysis, correlation, and Analysis of Variance (ANOVA) (10).

Results

Educational, Socio-Economic Status, Community Perception and Behavior

The Table 1 consisted of education level and Socio-economic status. Behavior and perception of people about water quality, its use and about water-borne diseases was also evaluated. Results revealed that illiteracy was high with 58% population while only 26% and 4% people had primary and middle level of education respectively and

10% population had education level of matric and above. Monthly household income of the population did not vary widely as 46% of the population had monthly income of Rs 5,000-10,000 and Rs ≥ 10,000 each while only 8% of the population had monthly income Rs <5,000. There was 46% population having 3 rooms while collectively, 38% of the population had one and two number of rooms in house. On contrary, 16% of the population had four or more number of rooms. In Saggian, major source of groundwater was Motor and 84% population utilized this source while only 8% population was using hand pumps. The majority of population (76%) was unaware of pathogens while 24% perceived that water contains pathogen as well. A majority of 60% population had no knowledge of water-borne diseases while only 36% of the respondents knew that diarrhea and malaria were water-borne diseases and 4% population had perception that Hepatitis E was a water-borne disease. About 78% population was abstracting ground water at the rate of 2-3 hours per a day whereas 4% and 2% population had the use of 4-5 hours and 6 or more hours respectively per a day.

Occurrence of water-Borne diseases

Data of registered patients suffered with water-borne diseases was collected from basic health unit (for the year 2010) and nearest hospital (five years data: 2006-2010). The data from basic health unit showed that 1200 patients were exposed to diarrhea whereas 700 and 500 patients suffered with dysentery and typhoid respectively while malaria and skin diseases were also reported by 200 patients each as shown in Fig. 2. Five years data (2006-2010) on water-borne diseases (Fig. 3) revealed that stomach diseases were high among all (with patients 2816, 3416, 4709, 6173, 6509 in the years 2006-2010 respectively). Number of patients suffered with diarrhea followed the increasing order of 2232 > 2541 > 3508 > 3901 > 4213 over the five years whereas number of patients suffered with typhoid were 1973, 2402, 3223, 3413 and 4268 in the years 2006-2010 respectively.

Table 1: Education level, Socio-Economic Status, People Perception and Behavior

Variable	Description	Response rate
Education	Uneducated	58
	Primary	26
	Middle	4
	Matric	6
	Above matric	6
Income	Rs < 5,000	8
	Rs 5,000-10,000	46
	Rs $\geq$ 10,000	46
No. of rooms	1	12
	2	26
	3	46
	4 or more	16
Water source	Motor	84
	Hand pump	16
Perception: water is free from pathogens	Yes	76
	No	24
Perception about water-borne diseases	Diarrhea	18
	Malaria	18
	Hepatitis E	4
	Do not know	60
Use of motor per day	2-3 hours/day	78
	4-5 hours/day	4
	6 or more hours/day	2

Similarly, 846, 1142, 1260, 1366 and 1451 number of patients exposed to dysentery in the years 2006-2010 respectively. Number of patients exposed to malaria followed the order of 544 > 551 > 627 > 772 > 792 for the years 2006-2010 respectively.
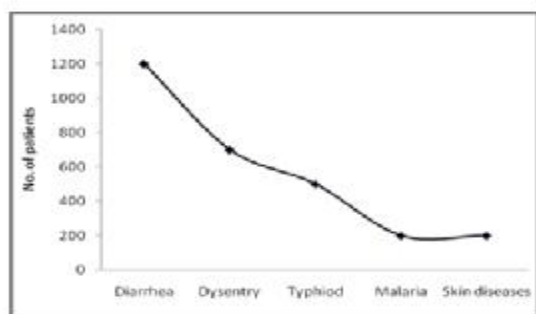
Fig.2: Number of patients suffered from water-borne diseases at basic health unit
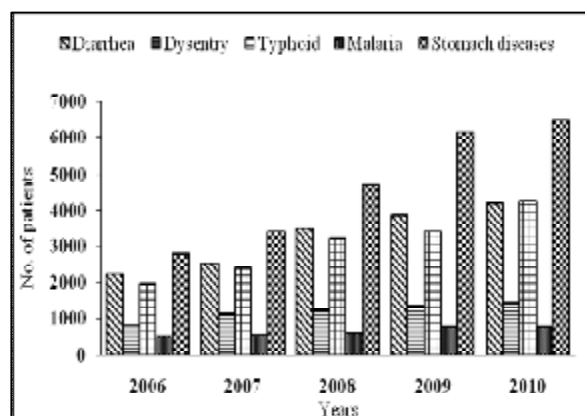
Fig.3: Five years registered data of the patients suffered from water-borne diseases

Cost of illness

The cost of illness due to water related diseases was calculated on the basis of the exposure of diseases in a certain time period (Table 2a & b). Among below poverty level income group, 50% population had exposure of disease once in two month with the direct cost of illness (medication) around US$ 0.6—1.2 (Rs 50-100) per day whereas 25 % population each had exposure to diseases once in a month and once in six months with expenses of US$ 2.3 (Rs 200) and US$ 1.8 (Rs 150) per day respectively. Among low income level group, 44% of the population had exposure of diseases once in a month, and had to bear the direct cost of illness around US$ 2.3 (Rs 200) per day where as 30% of the population stated that for the diseases that had exposure of once in six months, the direct cost of illness was US$ 1.8 (Rs 150) per day while only 26 % population had exposure of diseases once in two months with the direct cost of illness around US$ 0.6—1.2 (Rs 50—100) per a day. Among the average income level group, 46% of the respondents had diseases exposure once in a month with direct cost of illness of US$ 2.3 (Rs 200) per day. On contrary, 32% population with diseases exposure of once in six months was bearing the cost of US$ 1.8 (Rs 150) per day while only 22% people had diseases exposure of once in two months with the direct cost of illness of US$ 0.6—1.2 (Rs 50—100) per a day. For below poverty level, water-borne diseases

were responsible for incurring the indirect cost of illness (loss of working days) of US$ 2.3 (Rs 200) per day. People with low level of income were acquiring the indirect cost of illness of US$ 3.5 (Rs 300) per day where as population having average level of income was facing the indirect cost of illness more than US$ 4.7 (Rs 400) per day as shown in Table 2a.

Table 2(a): Direct and indirect cost of illness per day with respect to diseases exposure and income levels

Variables	Description	Cost of Illness per day	
		Rupees	**$**
		Direct	
Exposure to disease	Once in a month	200	2.3
	Once in two months	50-100	0.6—1.2
	Once in six months	150	1.8
		Indirect	
Income levels	Below poverty level (Rs <5,000 ≈ < $59	200	2.3
	Low income level (Rs 5,000—10,000 ≈ b/w $59—$118)	300	3.5
	Average income level (Rs >10,000 ≈ >$118)	400	4.7

Table 2 (b): Response rates of various income groups exposed to different diseases

Variables	Exposure to disease	Response rate
Below poverty level	once in a month	25
	once in two months	50
	once in six months	25
Low income level	once in a month	44
	once in two months	26
	once in six months	30
Average income level	once in a month	46
	once in two months	22
	once in six months	32

Status of necessities at the area

The status of basic necessities in the area related to water and sanitation facilities were also inquired (Table 3). The whole population (100%) in Saggian had no access to piped-line water supply system and 88 % of the population argued the response as government did not provide the facility while 6% of respondents stated that they never felt the need of facility whereas 6% of the respondents referred it to lack of development in the area. A majority of population (98%) believed that the status of garbage collection was bad and only 2% found it normal. About 92% of the population reported that sewerage disposal system was also in bad condition while 8% reported it normal. There was 100% need of piped-line water supply system (PWSS) and sewerage disposal system.

Table 3 : Status of basic necessities at the area

Variables	Description	Response rate
Piped-line water supply system (PWSS)	Yes	0
	No	100
Reason for no PWSS.	Government did not provide it	88
	Do not need it	6
	Development is not occurred yet	6
Status of sewerage disposal system in Area	Bad	92
	Normal	8
Need for PWSS and sewerage disposal system	Yes	100
	No	0

Behavior of community to pay for basic necessities as diseases interventions

The assessment of community's behavior towards certain facility provisions for diseases interventions was also described in Table 4. Majority of the population (96%) believed that government was responsible to provide the facilities like water supply and sewerage disposal system while only 4% population preferred major authoritative people of community for the provisions. On contrary, for 24% population, it was barely acceptable to pay for the facility provisions while 60% accepted to pay for these needs whereas 16% people refused to pay for the facilities as majority of the population (10%) wanted governmental facilities instead of their own whereas 2% population could not bear the expenses and 4% had distrust on governmental institutions. Majority (62%) had the water requirements for 2 hours in the morning, noon and evening whereas 30% people had the water demands for 3 hours while 6% and 2% people stated the water need for 1 and 4 hours respectively in the stated time.

**Table 4:** Behavior of community to pay for basic necessities

Variables	Description	Response rate
Preference for the facility provision	Government	96
	Major authoritative people of community	4
Acceptance to pay for PWSS and Sewerage System	Barely acceptable	24
	Acceptable	60
	Rejection	16
Reason for rejection	Cannot bear expenses	2
	Responsibility of government	10
	Distrust	4
Piped-line water supply	1 hour(morning, noon, evening)	6
	2 hours(morning, noon, evening)	62
	3 hours(morning, noon, evening)	30
	4 hours(morning, noon, evening)	2

According to majority (26%) of the population, willingness to pay (WTP) for piped-line water supply was US$ 3.6 per month while 16% people refused to pay for the facility. On contrary, for sewerage disposal system, 36% of the population was willing to pay US$ 1.2 (Rs 100) per month as shown in Fig. 4.

Correlations between acceptability to pay and other influential factors

Correlations between acceptance to pay, income, number of rooms, education, people perception and piped-line water supply time as shown in Table 5. Acceptance had significant positive correlation with income (r = 0.319; P < 0.05), number of rooms (r = 0.219; P < 0.05) and piped-line water supply system (r = 0.307; P < 0.05) whereas perception of clean drinking water had positive relation with demand of

piped-line water supply system (PWSS) (r = 0.439; P < 0.01).
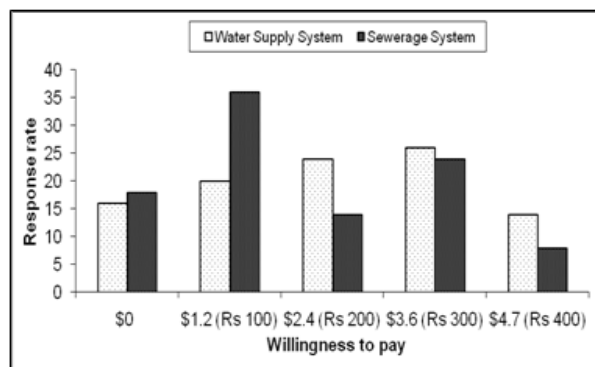
Fig. 4: Response rate of Willingness to pay ($, Rs) for Water supply and Sewerage system

Table 5: Correlations between Acceptability to pay and other influential factors

	Acceptance	Income	No. of rooms	Education	Perception	PWSS
Income	.319*	1				
No.of rooms	.291*	.591**	1			
Education	0.127	-0.122	0.018	1		
Perception	0.041	-0.191	-0.207	0.278	1	
PWSS	.307*	0.195	0.291	0.269	.439**	1

* Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

Relationship between willingness to pay for facilities and other controlling factors

Correlation between willingness to pay for the facilities as diseases interventions and other controlling factors is shown in Table 6. Income was strongly correlated with willingness to pay for water-supply system (r = 0.805; P < 0.01) and sewerage system (r = 0.797; P < 0.01) whereas illness also showed negative relationship with willingness to pay for water supply system (r = -0.336; P < 0.05).

Effect of various levels of income on WTP for water supply and sewerage system

The effect of various income levels on willingness to pay for water supply and sewerage system was determined by ANOVA as shown in Table 7a. There was

a significant effect of various levels of income on willingness to pay for sewerage system (F = 51.881, P < 0.05) and piped-line water supply system (F = 44.456, P < 0.05). In order to determine the influential income levels on willingness to pay, multiple comparison test was used by applying Post Hoc test (Table 7b). It revealed that there was significant mean difference in willingness to pay at income level of Rs > 10,000 and b/w Rs 5,000-10,000 as compared to income level of Rs < 5,000, which in turn was different from other income levels. For sewerage system, people with income levels Rs < 5,000 and Rs 5,000-10,000 reported low willingness to pay as compared to those with income level of Rs >10,000 which indicated that people with low income level stated low WTP.

Table 6: Relationship between willingness to pay and other controlling factors

	WTP for water supply	WTP for Sewe-rage system	Income	Perception	Illness
WTP for PWSS	1				
WTP for Sewe-rage System	.643**	1			
Income	.805**	.797**	1		
Perception	-.190	-0.82	-0.191	1	
Illness	-.336*	-.211	-.286	.066	1

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Table 7a: Effect of various level of income on WTP for Water Supply and Sewerage System

Income		SS	df	MS	F
WTP for sewerage system	Between Groups	52.913	2	26.456	51.881*
	Within Groups	23.967	47	0.51	
	Total	76.88	49		
WTP for PWSS	Between Groups	54.284	2	27.142	44.456*
	Within Groups	28.696	47	0.611	
	Total	82.98	49		

*indicates significance at 0.05 level

Table 7b: Effect of various level of income on WTP for water supply and sewerage system

Dependent va-riables	Independent variable			
	Income	Subset for alpha = 0.05		
		1	2	3
WTP for water supply	Rs <= 5000	1	---	---
	Rs 5000-10000	---	2.3	---
	Rs >= 10,000	---	---	4.09
	Income	Subset for alpha = 0.05		
		1	2	
WTP for sewerage system	Rs <= 5000	1.25	---	
	Rs 5000-10000	1.83	---	
	Rs >= 10,000	---	3.78	

Discussion

Results revealed that illiteracy was high whereas the status of income did not differ widely among the population. Majority of the population was abstracting ground water through motors excessively, which could be responsible for falling of water table (2). Majority of the population was unaware of pathogen contamination and believed the drinking water of good quality (10). The most of the community had no idea of water-borne diseases except some were aware of diarrhea and malaria. Status of basic necessities was also afflicted. Absence of such facilities can be attributed to poor health and diseases outbreak. In rural areas, lack of access to safe water, sanitation, and medical facilities is also a great concern (10). Poor water quality is responsible for diseases outbreaks in many parts of the developing world where water supply failures are reported as a cause of water-related outbreaks. In developing countries, improper drinking water and sanitation facilities are responsible for 80% of all illnesses (8). The status of water-borne diseases assured that health of the community was declining day by day. Data (Fig. 2) on water-borne diseases showed that highest numbers of patients suffered from diarrhea than from dysentery, typhoid, malaria, and skin diseases. The skin diseases may be owed to the presence of high arsenic contamination in drinking water. Similarly, the patients suffered from diarrhea showed an increasing trend over the years and increased risks of various diseases (Fig. 3). Diseases exposure for low and average income group was almost similar as once in a month, in two and six months (Table 2b). However for below poverty level income group, disease occurrence once in a month was almost half (25%) of the diseases exposure of once in two months (50%) as compared to other groups. It may be owed to the fact that the poor people sometimes remain uneducated and thus do not take diseases seriously. Direct cost of illness was low (US$ 0.6—1.2 per day) for the population with below poverty income level as compared to other income levels. This may be attributed to the people's concern towards medi-

cation. People having better income group had more concern about their health and so were taking proper medication against diseases and those having income level below poverty, had no trends to take proper medication either due to low income or perception about health and diseases.

A very cost effective intervention is to improve the drinking water systems according to standards, which reduce diarrheal diseases (12). Water and sanitation management practices will decrease diarrhea incidences by one-third to one-fourth (9). These interventions must be applied in relation with cultural sensitivity concerns, community priorities, knowledge, feasibility, and cost effectiveness (12). For sewerage disposal system, majority of the population was willing to pay (WTP) for US$ 1.2 per month. For water supply system, WTP was US$ 3.6 per month with the majority had water demand for 2 hours in the morning, noon, and evening.

Acceptance to pay showed a significant relationship with income and number of rooms (14). Having more number of rooms is associated with level of income and better socio-economic conditions so those having better living styles and socio-economic conditions had more acceptability to pay for water services. Acceptance to pay for water services showed significant relationship with the water requirements (Table 5). Those who needed more water supplies according to their needs were more ready to pay for it. Perception of water was strongly correlated with water supply showing that people having high perception and demand for safe water had more tendency and acceptance to pay for the facilities and vice versa. Income was strongly correlated with willingness to pay for water supply and sewerage system (18, 14). People with high income had high willingness to pay (14). For these commodities, zero willingness to pay was also reported by those who had low-income level and those who believed it as the responsibility of government to provide the facilities. People with low level of social capital like trust on government, had low acceptability and willingness to pay for the facilities and vice versa (18). There

was a significant effect of various levels of income on willingness to pay for sewerage system and piped-line water supply system. People with high-income level, had high willingness to pay as compared to those, with low-income level. Poor were less inclined to pay for water (14, 18, 19). Willingness to pay had negative correlation with illness which showed that even with high illness; people had low willingness to pay for water and vice versa. No significant effect of education was observed for willingness to pay for water supply service (14). As education arises awareness, and in the case, educational level of population was very low, so was the correlation of perception with WTP was low.

In conclusion, community awareness about water quality and diseases was very low. Occurrence of water-borne diseases like diarrhea, typhoid, malaria, skin diseases, and stomach diseases among the community was an indication of contaminated drinking water, bad sanitation. Population at poverty level appeared to have poor medication and less concerned to health as it was spending only US$ 0.6-1.2 per day for illness. Illness also contributed to the indirect cost of US$ 2.3 per day in below poverty level because of the loss of working days. Some 16 % of the population refused to pay for water supply whereas 20% population was willing to pay a minimum amount of US$ 1.2 (Rs 100) per month while 25% were agreed to pay on average of US$ 2.4 (Rs 200). Similarly, 18% population rejected to pay for sewerage facilities while majority of them (36%) were willing to pay a minimum amount of US$ 1.2 (Rs 100) per month. It appeared that income and demand of water supply system had strong relation with acceptability to pay for the facilities. On contrary, Illness of the community was negatively correlated with WTP for water supply system.

Water borne diseases have increased the cost of illness in direct and indirect terms leading to poverty in the end. Diseases interventions like the provision of safe drinking water supply, better sanitation and sewerage disposal facilities can be introduced and subsidized by the government may result in the reduction of diseases in the future.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors. Households were ensured that their information would only be used for research purposes

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